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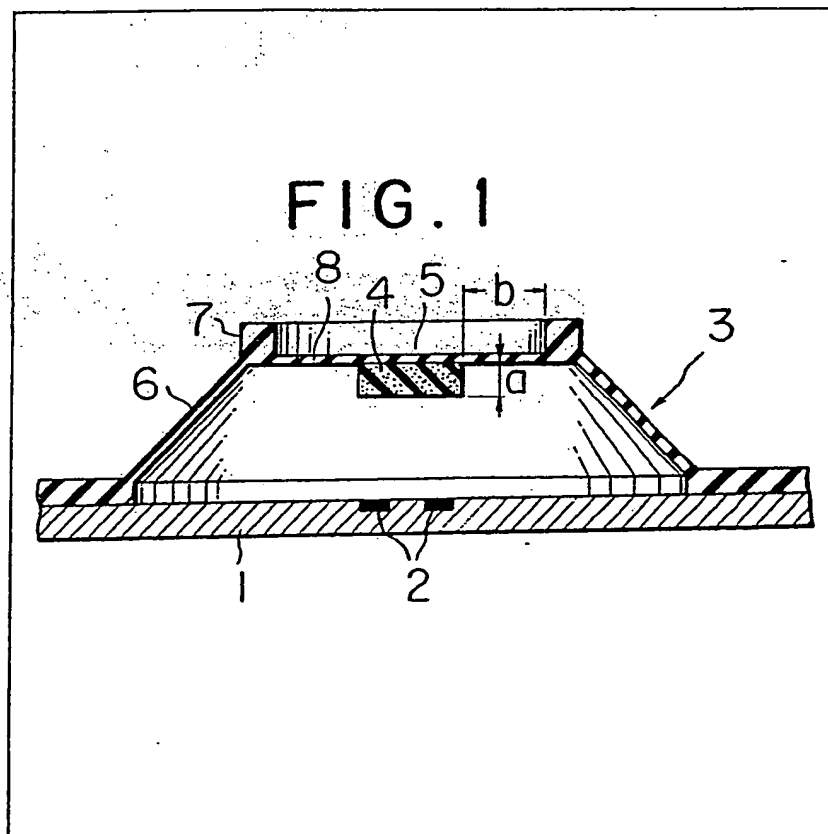
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(54) Push button switch

(57) In a push button switch having a base plate (1) provided with at least one pair of fixed contact points (2) thereon and a flexible cover member (3) having at least one dome-like portion (6) on the inner surface of which is mounted a movable contact (4), an outwardly extending annular rib (7) surrounds the movable contact

member (4) on the outside of the cover member (3). For engagement by the push button whereby over travel occurs as the central web 5 deflects. The ratio of the radial distance "b" between the outer periphery of the movable contact member (4) and the inner periphery of the rib (7) to the height "a" of protrusion of the movable contact member is stated to be at least 1.1 to provide a long service life.



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FIG. 1

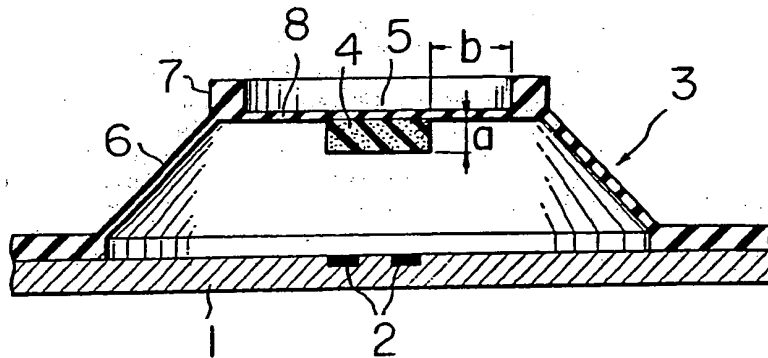
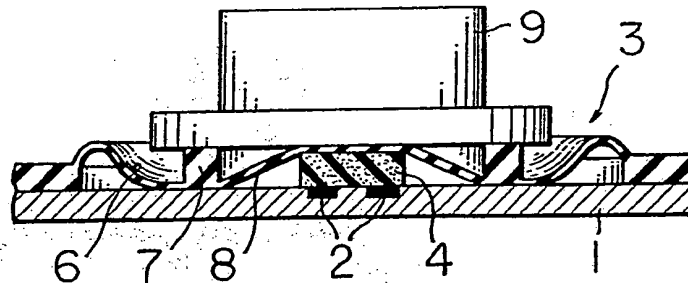


FIG. 2



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FIG. 3

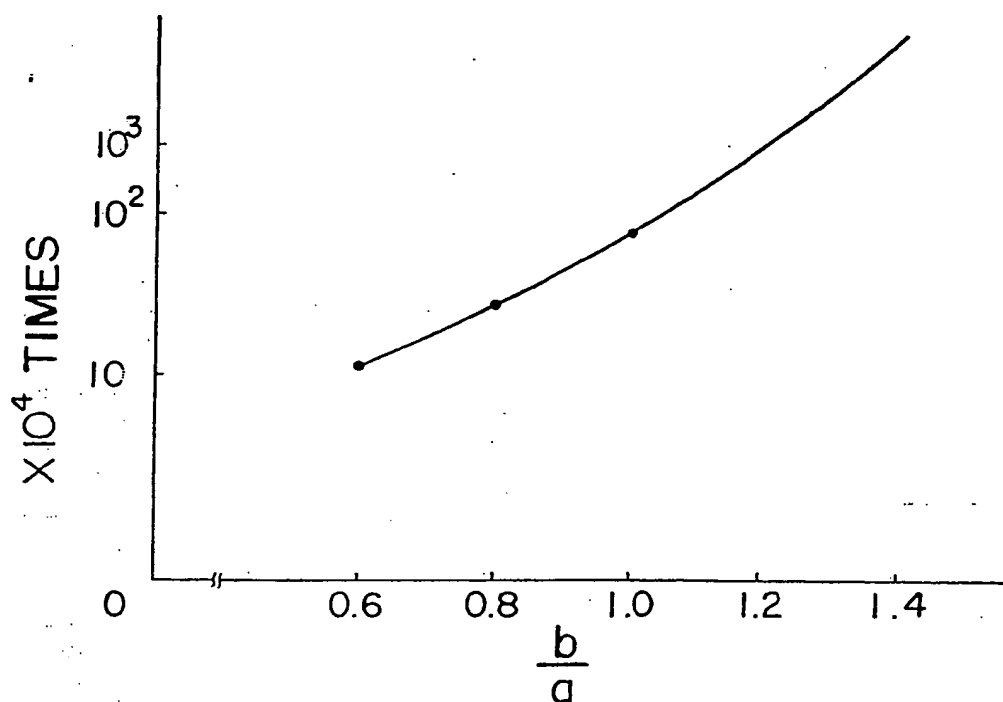


FIG. 4

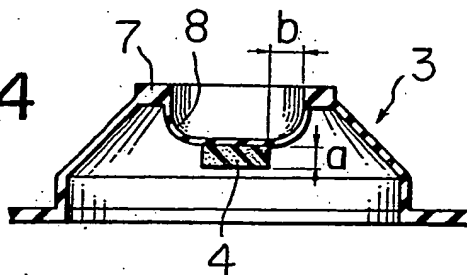
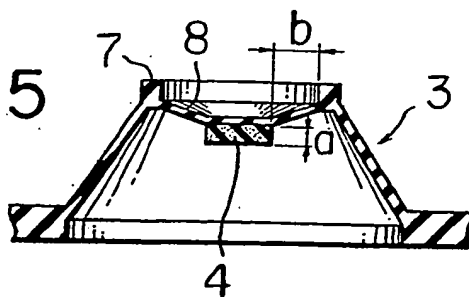


FIG. 5



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### Push button switch

The present invention relates to push button switches and, more particularly, to push button switches suitable for use in a key board switch panel in which long-life durability of the push button switch is of the utmost importance.

It is well known to use push button switches on a key board switch panel. Such a push button switch is usually formed by mounting a switch cover member made of an electrically insulating rubber sheet, having at least one dome-like raised portion, on a base plate having at least one pair of fixed contact points thereon. Pushing down the centre top flat of the dome-like raised portion brings a movable contact member bonded to the inner surface of the centre of the dome-like raised portion into contact with the fixed contact points on the base plate so as to close the electric circuit between them, and release of the pushing force enables the movable contact member to move apart from the fixed contact points by virtue of the elastic resilience of the switch cover member.

Conventional push button switches of the above described type are not always satisfactory in respect of the degree of touch required in pushing or feeling in operation since, once the movable contact member has come to contact with the fixed contact points, further thrusting of the top of the switch cover member is no longer possible even by an increased pushing force of the finger tip, thus causing a hard touch to the finger tip.

In recent years, it has been desired to improve the above mentioned touch in pushing of push button switches along with the performance and reliability in the switching action per se. That is, push button switches under trial are directed to give a buffer action to the pushing finger tip when the movable contact member has come into contact with the fixed contact points by enabling further thrusting of the centre top of the switch cover member.

Most of the push button switches with improved pushing touch as above mentioned comprise a switch cover member made of an electrically insulating rubber sheet and provided with at least one dome-like raised portion facing the fixed contact points on the base plate with an annular outwardly extending rib around the centre top flat of the dome-like raised portion, surrounding the movable contact member which is bonded to the inward surface of the centre top flat of the dome-like raised portion. Push button switches of this type are widely used on key board switch panels in which the pitch of the respective push button switches is in the range, say, from 14 mm to 25 mm, such as in cash registers, electric typewriters, computers, copying machines and other information processing instruments.

One of the problems in such a push button switch, with which an additional thrusting or so-called over-stroke of the centre top of the switch cover member is obtained after contacting of the movable contact member and the fixed contact points, is in the durability of the thin walled portion of the top portion of the switch cover member between the movable contact member at the centre and the outwardly protruded rib. This limitation in the durability of that portion is caused by the elastic fatigue of the rubber sheet of the portion being subjected to stretching by the pushing down of the centre top with an overstroke. For example, the serviceable life of conventional push button switches of this type does not usually exceed 1,000,000 operations of switching on and off, and no intensive investigations have been undertaken to obtain a push button switch of this type having a desired life in excess of 5,000,000 to 10,000,000 times of operation.

It is therefore an object of the present invention to provide a novel and improved push button switch of the above described type having an improved long-life durability, preferably over 5,000,000 times or more of operation and yet capable of giving a very pleasant touch of pushing to the finger tip pushing the top of the switch cover member.

According to the present invention a push button switch comprises a base plate made of an electrically insulating material; at least one pair of fixed contact points on the base plate; a switch cover member comprising an electrically insulating rubbery elastomer mounted on the base plate and having at least one dome-like raised portion over the fixed contact points on the base plate, to form a hollow space therebetween, the top of the dome-like raised portion having an outwardly extending annular rib; and a movable contact member formed of an electrically conductive rubbery elastomer and bonded to the inner surface of the top of the dome-like raised portion of the switch cover member to project inwardly therefrom over the fixed contact points on the base plate, the ratio of the radial distance between the outer periphery of the movable contact member and inner periphery of the annular rib to the projecting height of the movable contact member being at least 1.1.

Example of switches according to the invention will now be described with reference to the accompanying drawings in which:—

Figure 1 is a cross-sectional view of a typical model of the push button switch of the invention.

Figure 2 is a cross-sectional view of the same push button switch as in Figure 1 as depressed to the state of overstroke.

Figure 3 is a graph obtained by plotting the results of the durability test by taking the value of  $b/a$  ratio as the abscissa and the maximum number of operations as the ordinate, and,

Figures 4 and 5 are cross-sectional views of two different models of switch cover member.

Figure 1 illustrates a push button switch according to the invention in cross-section, the switch being composed of a base plate 1 made of an electrically insulating material which is preferably rigid, a

- pair of fixed contact points 2,2, provided on the surface of the base plate 1, a switch cover member 3 made of an electrically insulating rubber sheet, and a movable contact member 4 formed, preferably, of an electrically conductive rubber bonded to the inner surface of the centre top flat 5 of the dome-like raised portion 6 of the switch cover member 3. The movable contact member 4 is in the form of a downwardly extending stud having a height "a" as is shown in Figure 1. The switch cover member 3 is provided with an outwardly extending ring-like rib 7 around the centre top flat 5 surrounding the movable contact member 4 and leaving a thin walled portion 8 between the movable contact member 4 and the annular rib 7 having a radial width "b" as is indicated in Figure 1. In other words, the distance from the outer periphery of the movable contact member 4 to the inner periphery of the annular rib 7 is given by "b".
- The switch cover member 3 is pushed down at the rib 7 by a key or switch top 9, so that the switch cover member 3 is deformed first at the side surface of the dome-like raised portion 6 until the lower surface of the movable contact member 6 until the lower surface of the movable contact member 4 comes to contact with the fixed contact points 2,2, on the base plate 1. During this stroke, the centre top flat 5 remains flat and undeformed.
- When the key top 9 is further pushed down beyond this critical contact point the movable contact member 4 is no longer downwardly movable so that the rib 7 is depressed down relative to the movable contact member 4 until the lower surface of the rib 7 comes into contact with the surface of the base plate 1, as is shown in Figure 2. As is readily understood from this figure, the thin walled portion 8 between the movable contact member 4 and the rib 7 is in a stretched state in this ultimate state of overstroke.
- Release of the pushing force on the key top 9 naturally restores the switch cover member 3 to its original undepressed state shown in Figure 1 in which the thin walled portion 8 is consequently in an unstretched state. Thus, the thin walled portion 8 is subjected to the repetition of stretching and contracting in each pushing operation of the push button switch so that the elastic fatigue in this portion 8 is the limiting factor for the durability of the push button switch.
- In a key board switch panel used in cash registers, electric typewriters, computers and the like, the distance of movement during operation and/or the load to cause the overstroke must be adjusted in certain ranges from the standpoint of working efficiency as well as the health of the operators. For example, key board switch panels are usually designed so that the working load on the key top before the critical contact is in the range from 40 to 150 g, the load of overstroke at the moment when the lower surface of the ring-wise rib is near to contact with the base plate is in the range from 70 to 200 g and the distance of the overstroke is in the range from 1.0 to 2.5 mm.
- The above described desired conditions are largely determined by the form and material of the switch cover member 3. For example, the hardness of the rubbery elastomer for the switch cover member 3 is preferably in the range from 30 to 70 by the JIS scale, though this is not limitative. Furthermore, the thickness of the thin walled portion 8 should be in the range from 0.15 to 0.50 mm in order that the load for the overstroke is in the above specified preferable range.
- In carrying out extensive investigations for improving the touch of pushing as well as the durability of the push button switches of the above described type, it was found that the most determinative parameter for the above purpose is the ratio of the distance "b" from the outer periphery of the inwardly protruded movable contact member 4 to the inner periphery of the outwardly protruded rib 7 to the height of the protrusion "a" of the movable contact member 4.
- Accordingly, a durability test of push button switches having varied values of the b/a ratio above mentioned was conducted to give the results set out in the table below, from which it is very apparent that the value of the b/a ratio of 1:1 is critical in order that the push button switch has a durability in excess of 5,000,000 operations or more. The results are also plotted in Figure 3 from which the same conclusion can be reached that the value of the b/a ratio should be at least 1:1 or, preferably, 1:2.

## Results of Durability Test

b/a	Degree of stretching %	Operation durability ( $\times 10^4$ times)				
		1	2	3	4	5
0.6	95	15	23	18	15	15
0.8	60	38	42	36	51	43
1.0	41	89	103	85	93	110
1.1	37	500	550	530	520	560
1.2	30	905	870	860	920	900
3	25	1110	1150	1350	1250	1200
	23	*	*	*	*	*

Note 1: The symbol \* means interruption of measurement at 14,000,000 times.

Note 2: The operation durability test was carried out by repeated operation of the button at a rate of 2 times per second.

Figure 4 and Figure 5 each illustrate a modification of the switch cover member 3. In the models illustrated in these figures, the thin walled portion 8 between the movable contact member 4 and the ring-wise rib 7 is not formed as a centre top flat, but is shaped in a curve or inclined so as that the rib 7 is raised higher above the movable contact member 4. However, the principle of the present invention is equally applicable to these models so that the radial distance "b" from the outer periphery of the movable contact member 4 to the inner periphery of the ring-wise rib 7 should be at least 1.1 times larger than the height of protrusion "a" of the movable contact member 4 whereby a good touch of pushing and unexpectedly long durability in operation of the switch can be ensured.

The suitable rubbery elastomer materials for making the switch cover member in the present invention are not particularly limited, but preferably a silicone rubber is used because of its heat resistance, aging resistance, workability and electric properties although natural rubber and other kinds of synthetic rubbers may be used.

## CLAIMS

1. A push button switch comprising a base plate made of an electrically insulating material; at least one pair of fixed contact points on the base plate; a switch cover member comprising an electrically insulating rubbery elastomer mounted on the base plate and having at least one dome-like raised portion over the fixed contact points on the base plate, to form a hollow space therebetween, the top of the dome-like raised portion having an outwardly extending annular rib; and a movable contact member formed of an electrically conductive rubbery elastomer and bonded to the inner surface of the top of the dome-like raised portion of the switch cover member to project inwardly therefrom over the fixed contact points on the base plate, the ratio of the radial distance between the outer periphery of the movable contact member and the inner periphery of the annular rib to the projecting height of the movable contact member being at least 1.1.
2. A switch according to claim 1, wherein the dome-like raised portion has a flat top.
3. A switch according to claim 1, wherein the dome-like raised portion has an inwardly convex top.
4. A switch according to claim 1, substantially as described with reference to any of the accompanying drawings.

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